

## 1. General description

WG50N65HDE1 uses advanced Fine Trench Field-stop IGBT technology with anti-parallel diode in IITO247 package to provide extremely low  $V_{ce(sat)}$ , and excellent switching performance. This device offers Best-in-Class efficiency in hard switching and resonant topology.



## 2. Features and benefits

- Maximum junction temperature 175 °C
- Positive temperature efficient for easy paralleling
- Very soft, fast recovery anti-parallel diode
- High speed switching
- EMI Improved Design

## 3. Applications

- PFC
- Solar converters
- UPS
- Welding Converters
- Mid to high range switching frequency converters

## 4. Quick reference data

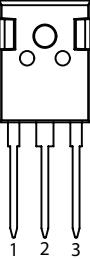
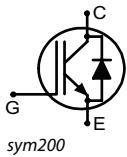
Table 1. Quick reference data

Symbol	Parameter	Notes	Value			Unit
$V_{ce}$	Collector-emitter voltage, $T_j \geq 25$ °C		650			V
$I_c$	DC collector current, limited by $T_{j(max)}^{(1)}$ $T_c = 100$ °C		50			A
Symbol	Parameter	Conditions	Notes	Min	Typ	Max
<b>Static characteristics</b>						
$V_{ce(sat)}$	Collector-emitter saturation voltage	$V_{ge} = 15$ V; $I_c = 50$ A; $T_j = 25$ °C		-	1.55	2.0

Note(1):  $I_c$  and other electrical parameters definition follow TO247 package.

## 5. Pinning information

Table 2. Pinning information

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	G	gate		
2	C	collector		
3	E	emitter		
mb	n.c.	mounting base; isolated		

## 6. Ordering information

Table 3. Ordering information

Type number	Package Name	Orderable part number	Packing method	Small packing quantity	Package version	Package issue date
WG50N65HDE1	IITO247	WG50N65HDE1Q	Tube	30	-	-

## 7. Marking

Table 4. Marking codes

Type number	Marking codes
WG50N65HDE1	WG50N 65HDE1

## 8. Limiting values

Table 5. Limiting values

Symbol	Parameter	Notes	Value	Unit
$V_{CE}$	Collector-emitter voltage, $T_j \geq 25^\circ\text{C}$		650	V
$I_C$	DC collector current, limited by $T_{j(\text{max})}$ $T_c = 25^\circ\text{C}$ $T_c = 100^\circ\text{C}$		100 50	A
$I_{C(\text{puls})}$	Pulsed collector current, $t_p$ limited by $T_{j(\text{max})}$		150	A
-	Turn off safe operating area $V_{CE} \leq 650\text{ V}$ , $T_j \leq 175^\circ\text{C}$ , $t_p = 1\text{ }\mu\text{s}$		150	A
$I_F$	Diode forward current, limited by $T_{j(\text{max})}$ $T_c = 25^\circ\text{C}$ $T_c = 100^\circ\text{C}$		20 10	A
$I_{F(\text{puls})}$	Diode pulsed current, $t_p$ limited by $T_{j(\text{max})}$		40	A
$V_{GE}$	Gate-emitter voltage		$\pm 20$	V
$P_{\text{tot}}$	Power dissipation $T_c = 25^\circ\text{C}$ Power dissipation $T_c = 100^\circ\text{C}$		94 47	W
$T_{\text{stg}}$	Storage temperature		-55 to 150	$^\circ\text{C}$
$T_{j(\text{max})}$	Maximum operating junction temperature		175	$^\circ\text{C}$
-	Peak soldering temperature		260	$^\circ\text{C}$
M	Mounting Torque with washer		0.55	Nm

## 9. Thermal characteristics

Table 6. Thermal characteristics

Symbol	Parameter	Conditions	Notes	Min	Typ	Max	Unit
$R_{th(j-c)}$	IGBT thermal resistance from junction to case			-	0.7	-	K/W
$R_{th(j-c)}$	Diode thermal resistance from junction to case			-	3.2	-	K/W
$R_{th(j-a)}$	thermal resistance from junction to ambient			-	40	-	K/W

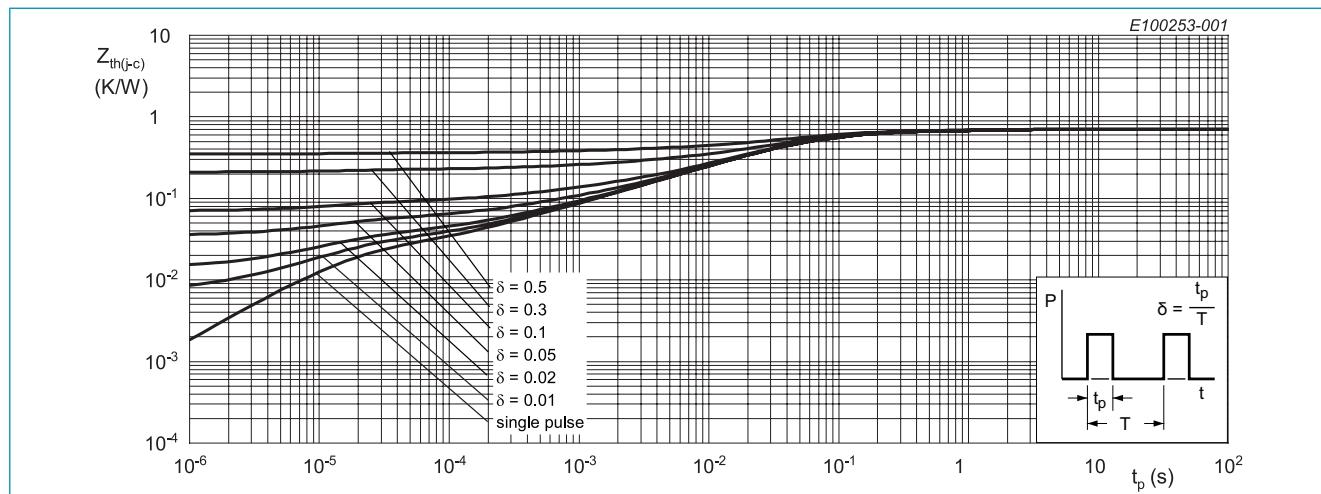


Fig. 1. Transient thermal impedance from junction to case as a function of pulse duration; IGBT

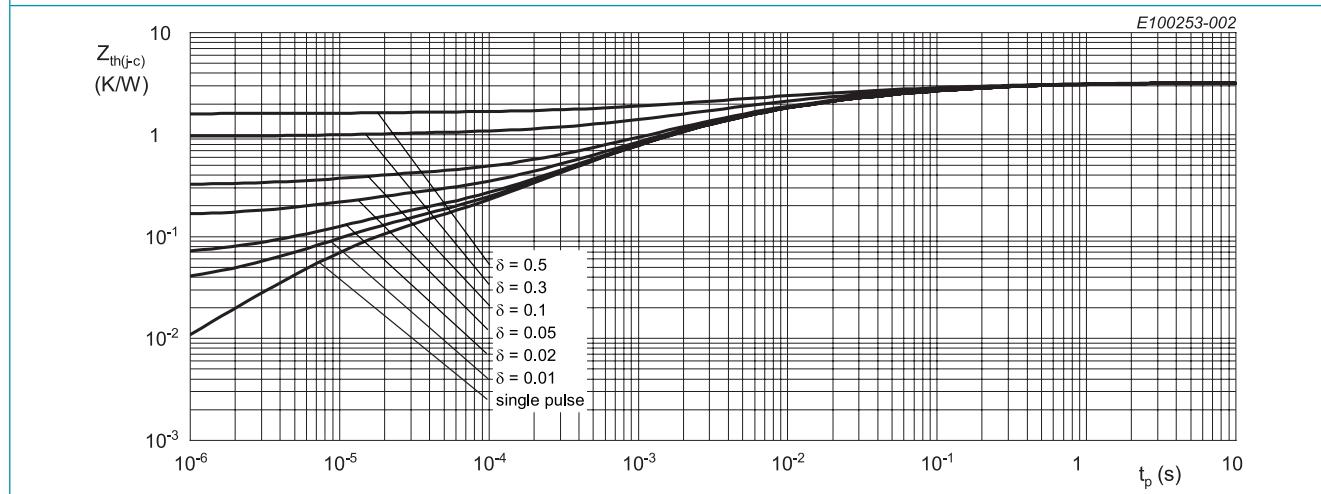


Fig. 2. Transient thermal impedance from junction to case as a function of pulse duration; Diode

## 10. Characteristics

Table 7. Characteristics

Symbol	Parameter	Conditions	Notes	Min	Typ	Max	Unit
<b>Static characteristics</b>							
$BV_{CES}$	Collector-emitter breakdown voltage	$V_{GE} = 0 \text{ V}; I_C = 100 \text{ uA}$		650	-	-	V
$V_{CE(\text{sat})}$	Collector-emitter saturation voltage	$V_{GE} = 15 \text{ V}; I_C = 50 \text{ A}; T_j = 25 \text{ }^\circ\text{C}$		-	1.55	2.0	V
		$V_{GE} = 15 \text{ V}; I_C = 50 \text{ A}; T_j = 175 \text{ }^\circ\text{C}$		-	1.95	-	V
$V_F$	Diode forward voltage	$V_{GE} = 0 \text{ V}; I_F = 10 \text{ A}; T_j = 25 \text{ }^\circ\text{C}$		-	1.7	-	V
		$V_{GE} = 0 \text{ V}; I_F = 10 \text{ A}; T_j = 175 \text{ }^\circ\text{C}$		-	1.45	-	V
$V_{GE(\text{th})}$	Gate-emitter threshold voltage	$I_C = 500 \text{ uA}; V_{CE} = V_{GE}$		3.6	4.5	5.4	V
$I_{CES}$	Zero gate voltage collector current	$V_{CE} = 650 \text{ V}; V_{GE} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$		-	-	100	uA
		$V_{CE} = 650 \text{ V}; V_{GE} = 0 \text{ V}; T_j = 175 \text{ }^\circ\text{C}$		-	-	1	mA
$g_{fs}$	Transconductance	$V_{CE} = 20 \text{ V}; I_C = 50 \text{ A}$		-	47	-	S
<b>Dynamic characteristics</b>							
$C_{ies}$	Input capacitance	$V_{CE} = 30 \text{ V}; V_{GE} = 0 \text{ V}; f = 1 \text{ MHz}; T_j = 25 \text{ }^\circ\text{C}$		-	2955	-	pF
$C_{oes}$	Output capacitance			-	105	-	pF
$C_{res}$	Reverse transfer capacitance			-	41	-	pF
$Q_G$	Gate charge	$V_{CC} = 520 \text{ V}; I_C = 50 \text{ A}; V_{GE} = 15 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$		-	138	-	nC

## 11. Switching Characteristics

Table 8. Switching Characteristics, Inductive Load

Symbol	Parameter	Conditions	Notes	Min	Typ	Max	Unit
<b>IGBT characteristics</b>							
$t_{d(on)}$	Turn-on delay time	$T_j = 25^\circ\text{C}$ ; $V_{CC} = 400\text{ V}$ ; $I_C = 50\text{ A}$ ; $V_{GE} = 15\text{V} / 0\text{V}$ ; $R_G = 10\text{ ohm}$		-	35	-	nS
$t_r$	Rise time			-	40	-	nS
$t_{d(off)}$	Turn-off delay time			-	188	-	nS
$t_f$	Fall time			-	38	-	nS
$E_{on}$	Turn-on energy			-	1.1	-	mJ
$E_{off}$	Turn-off energy			-	0.6	-	mJ
$E_{ts}$	Total switching energy			-	1.7	-	mJ
$t_{d(on)}$	Turn-on delay time	$T_j = 175^\circ\text{C}$ ; $V_{CC} = 400\text{ V}$ ; $I_C = 50\text{ A}$ ; $V_{GE} = 15\text{V} / 0\text{V}$ ; $R_G = 10\text{ ohm}$		-	33	-	nS
$t_r$	Rise time			-	39	-	nS
$t_{d(off)}$	Turn-off delay time			-	214	-	nS
$t_f$	Fall time			-	34	-	nS
$E_{on}$	Turn-on energy			-	1.45	-	mJ
$E_{off}$	Turn-off energy			-	0.7	-	mJ
$E_{ts}$	Total switching energy			-	2.15	-	mJ
<b>Diode characteristics</b>							
$t_{rr}$	Reverse recovery time	$T_j = 25^\circ\text{C}$ ; $V_R = 400\text{ V}$ ; $I_F = 10\text{ A}$ ; $dI_F/dt = 500\text{A/us}$		-	32	-	nS
$Q_r$	Reverse recovery charge			-	148	-	nC
$I_{RM}$	Reverse recovery peak current			-	8	-	A
$t_{rr}$	Reverse recovery time	$T_j = 175^\circ\text{C}$ ; $V_R = 400\text{ V}$ ; $I_F = 10\text{ A}$ ; $dI_F/dt = 500\text{A/us}$		-	71	-	nS
$Q_r$	Reverse recovery charge			-	508	-	nC
$I_{RM}$	Reverse recovery peak current			-	12	-	A

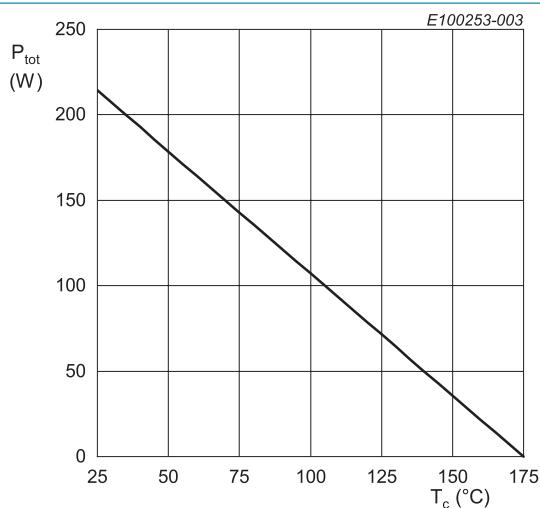
 $T_j \leq 175$  °C

Fig. 3. Power dissipation as a function of case temperature

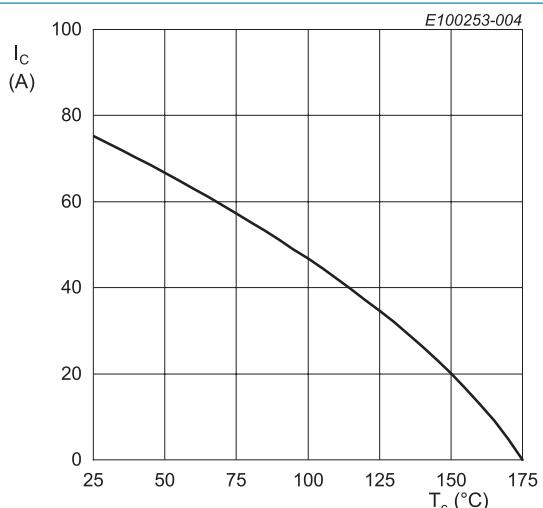
 $V_{GE} \geq 15$  V;  $T_j \leq 175$  °C

Fig. 4. Collector current as a function of case temperature

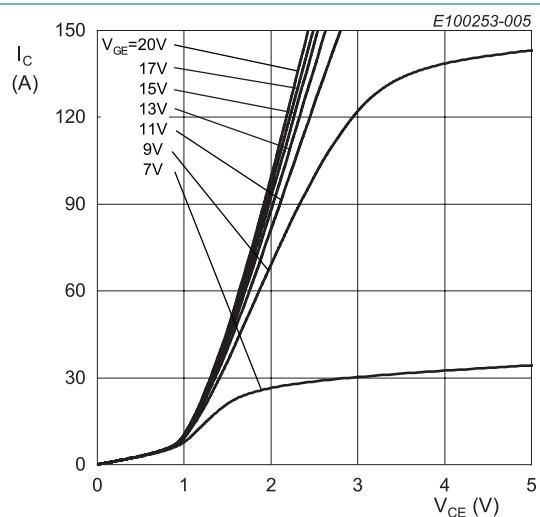
 $T_j = 25$  °C

Fig. 5. Typical output characteristic

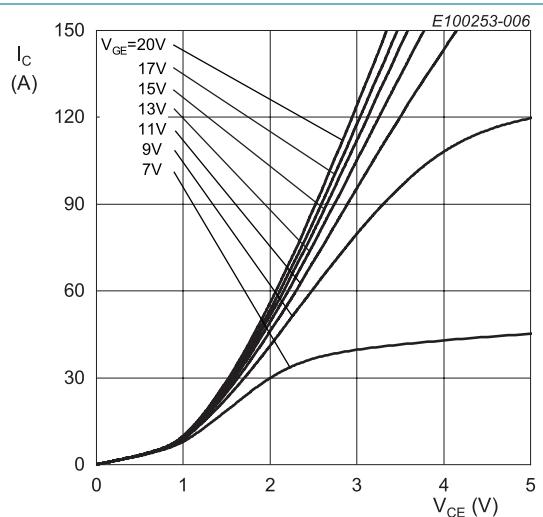
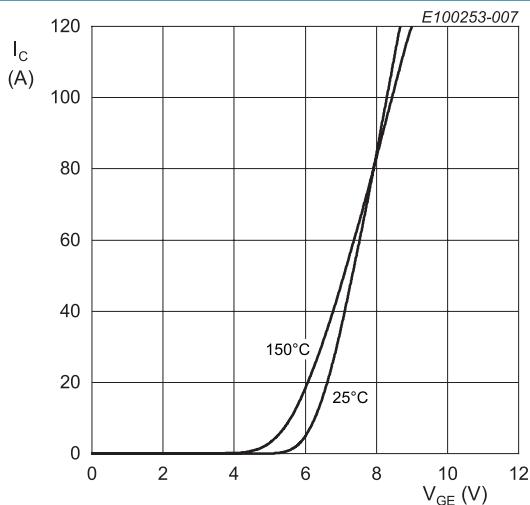
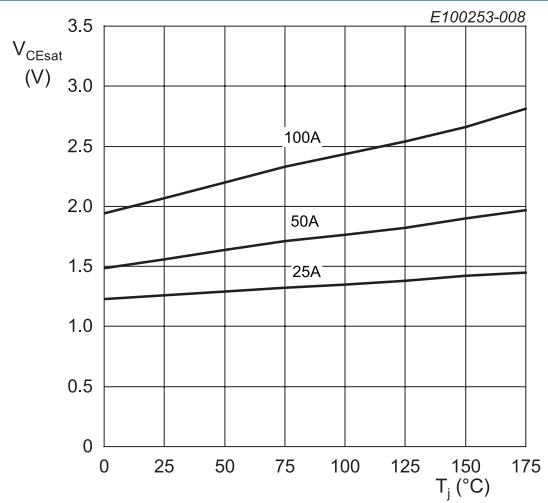
 $T_j = 175$  °C

Fig. 6. Typical output characteristic



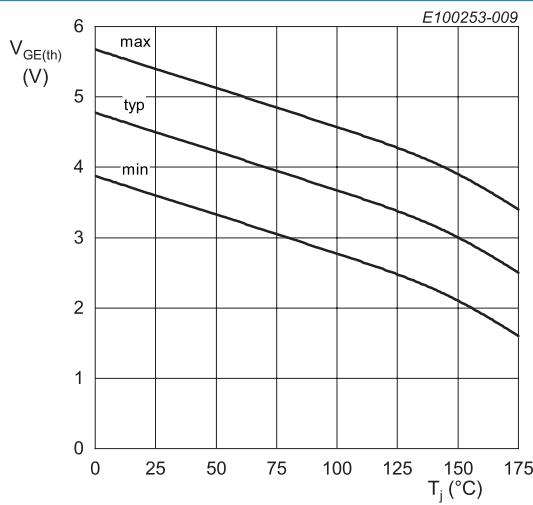
$V_{CE} = 20$  V

Fig. 7. Typical transfer characteristic



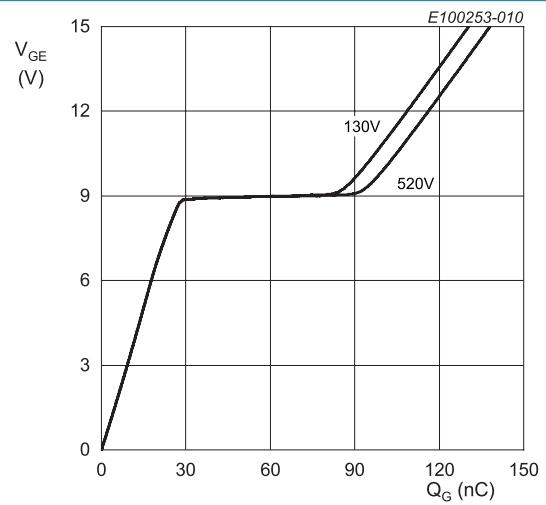
$V_{GE} = 15$  V

Fig. 8. Typical collector-emitter saturation voltage as a function of junction temperature



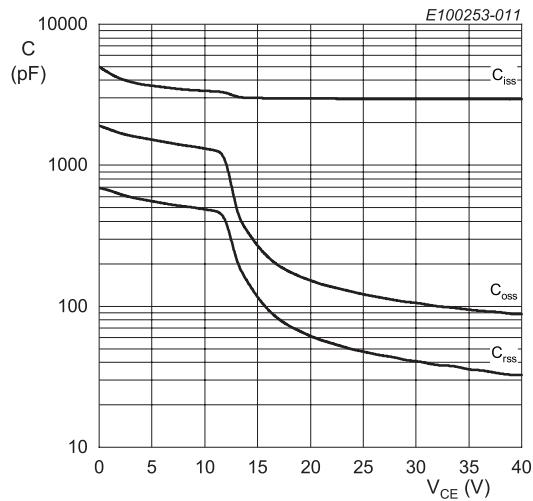
$I_C = 500$   $\mu$ A

Fig. 9. Gate-emitter threshold voltage as a function of junction temperature



$I_C = 50$  A

Fig. 10. Typical gate charge



$V_{GE} = 0 \text{ V}$ ;  $f = 1 \text{ MHz}$

Fig. 11. Typical capacitance as a function of collector-emitter voltage

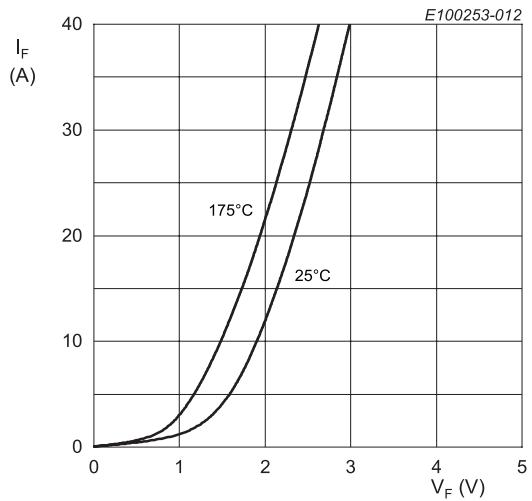
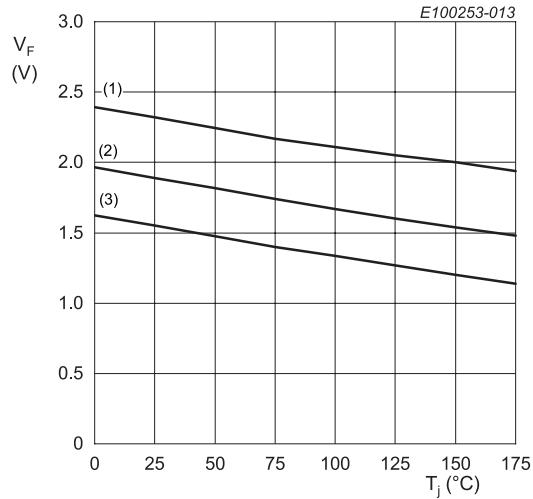
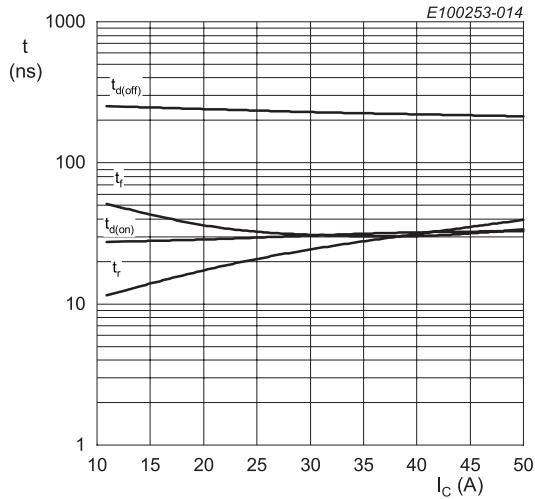


Fig. 12. Typical diode forward current as a function of forward voltage



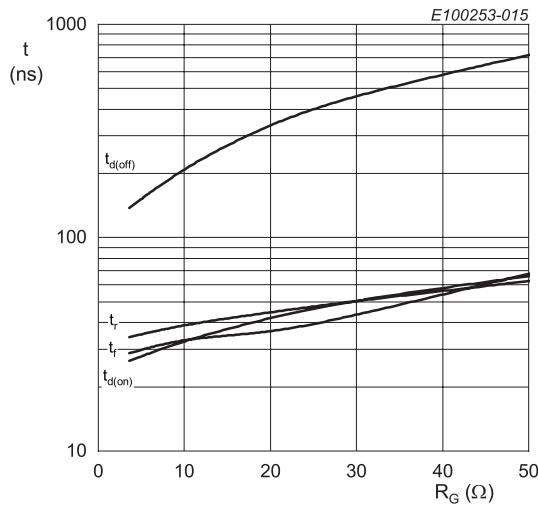
- (1)  $I_F = 20 \text{ A}$
- (2)  $I_F = 10 \text{ A}$
- (3)  $I_F = 5 \text{ A}$

Fig. 13. Typical diode forward voltage as a function of junction temperature



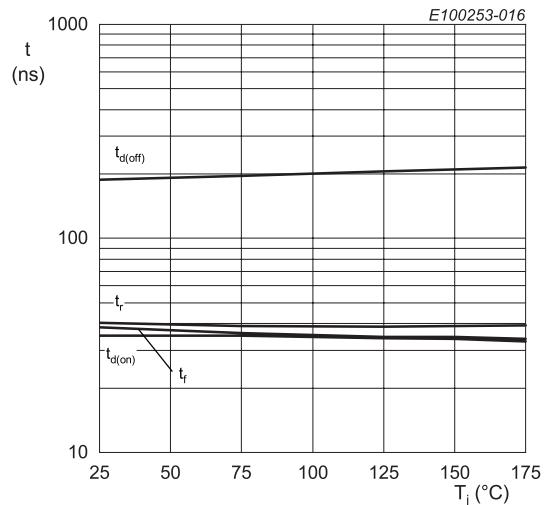
$R_g = 10 \Omega$ ;  $V_{GE} = 15 \text{ V} / 0 \text{ V}$ ;  $T_j = 175 \text{ }^\circ\text{C}$ ;  
 $V_{CE} = 400 \text{ V}$ ; inductive load

Fig. 14. Typical switching times as a function of collector current



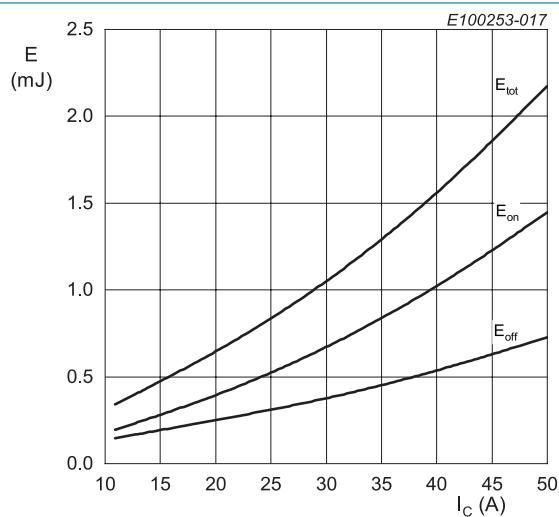
$I_C = 50 \text{ A}$ ;  $V_{GE} = 15 \text{ V} / 0 \text{ V}$ ;  $T_j = 175 \text{ }^\circ\text{C}$ ;  
 $V_{CE} = 400 \text{ V}$ ; inductive load

**Fig. 15. Typical switching times as a function of gate resistance**



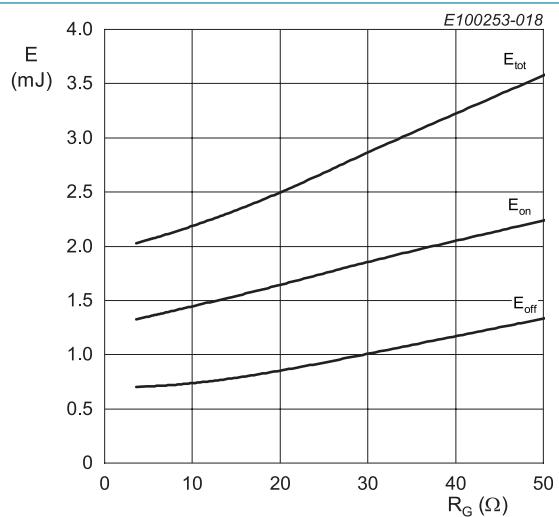
$I_C = 50 \text{ A}$ ;  $V_{GE} = 15 \text{ V} / 0 \text{ V}$ ;  $R_g = 10 \Omega$ ;  
 $V_{CE} = 400 \text{ V}$ ; inductive load

**Fig. 16. Typical switching times as a function of junction temperature**



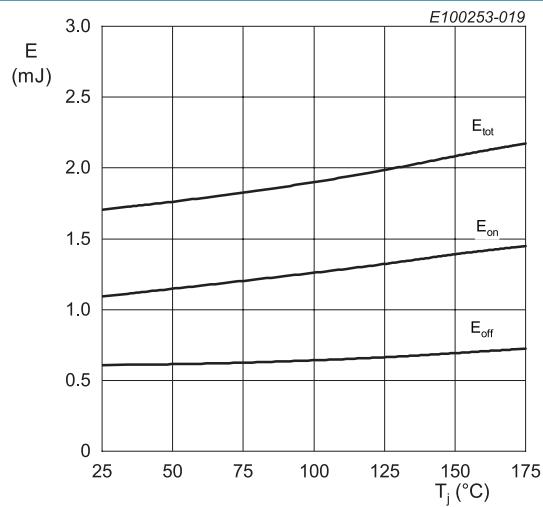
$R_g = 10 \Omega$ ;  $V_{GE} = 15 \text{ V} / 0 \text{ V}$ ;  $T_j = 175 \text{ }^\circ\text{C}$ ;  
 $V_{CE} = 400 \text{ V}$ ; inductive load

**Fig. 17. Typical switching energy losses as a function of collector current**



$I_C = 50 \text{ A}$ ;  $V_{GE} = 15 \text{ V} / 0 \text{ V}$ ;  $T_j = 175 \text{ }^\circ\text{C}$ ;  
 $V_{CE} = 400 \text{ V}$ ; inductive load

**Fig. 18. Typical switching energy losses as a function of gate resistance**



$I_C = 50 \text{ A}$ ;  $V_{CE} = 15 \text{ V} / 0 \text{ V}$ ;  $R_g = 10 \Omega$ ;  
 $V_{CE} = 400 \text{ V}$ ; inductive load

Fig. 19. Typical switching energy losses as a function of junction temperature

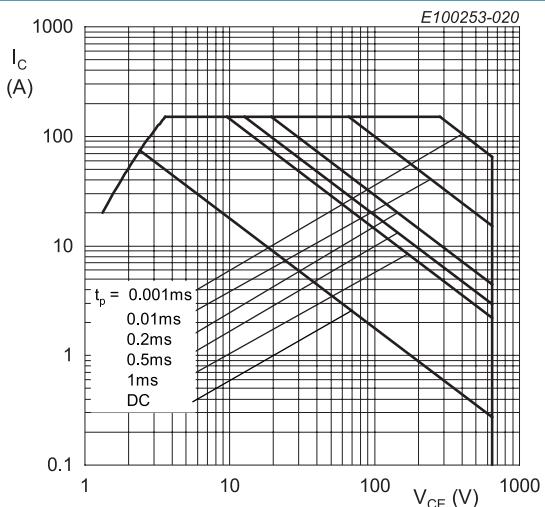


Fig. 20. Forward bias safe operating area

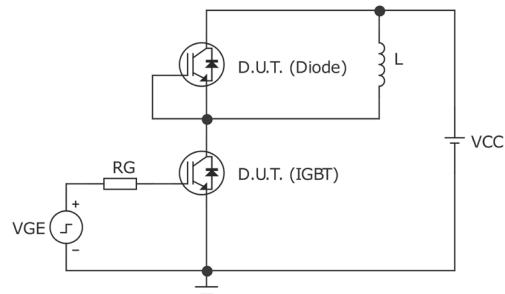


Fig. 21. Test circuit for inductive load switching

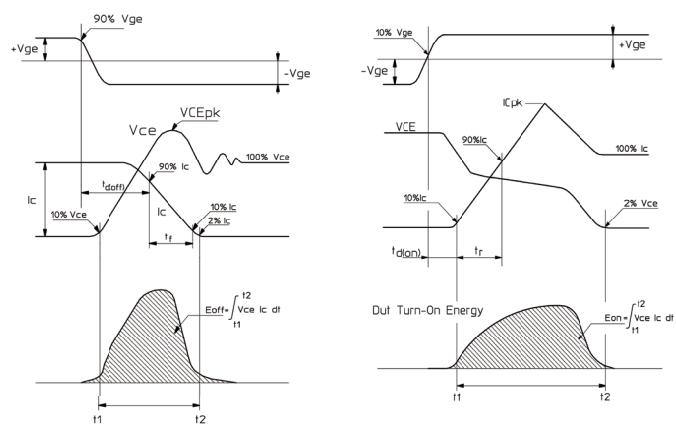
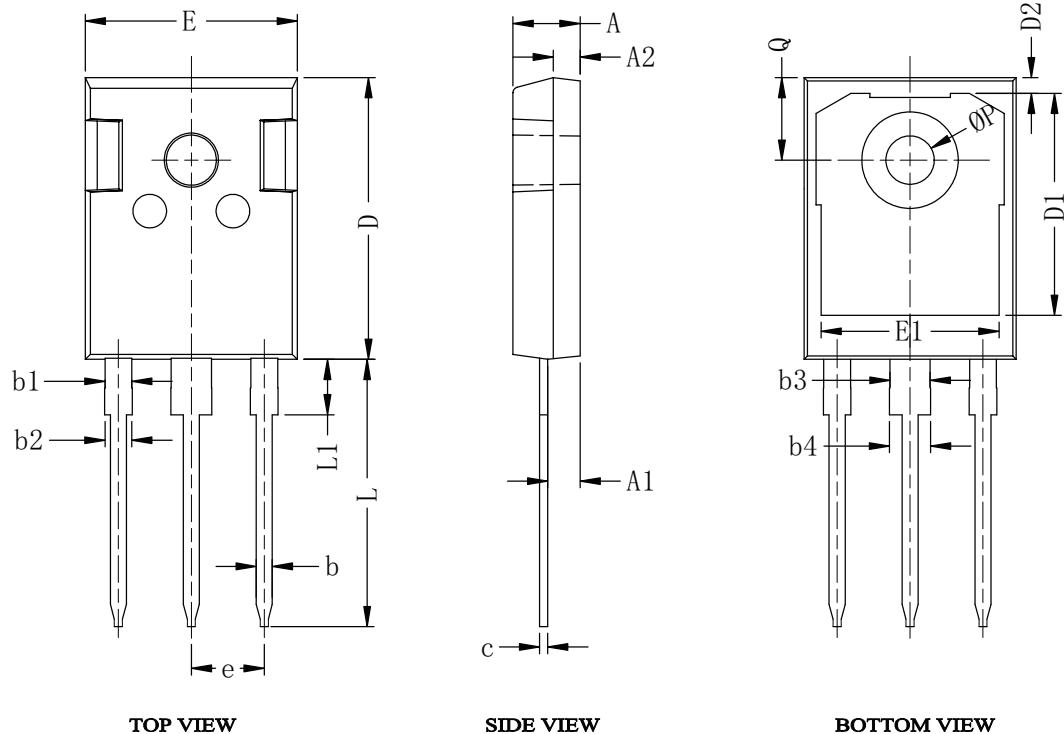


Fig. 22. Definition of switching times and losses

## 12. Package outline

Plastic single-ended through-hole package; isolated heatsink mounted; 1 mounting hole; 3 leads TO-247 IIT0247



UNIT	A	A1	A2	b	b1	b2	b3	b4	c	D	D1	D2	E	E1	e	L	L1	P	Q
mm	MAX	5.10	2.52	2.10	1.27	2.07	2.20	3.07	3.20	0.66	21.10	16.51	1.35	15.90	13.50				
	NOM	4.90	2.31	1.90	1.14	1.94	2.00	2.94	3.00	0.57	20.90	15.91	1.05	15.70	13.06	5.44	20.12	4.30	3.70
	MIN															19.72	3.55	6.15	

Note:

1. All dimensions do not include mold flash & gate remain

## 13. Legal information

### Data sheet status

Document status [1][2]	Product status [3]	Definition
Objective [short] data sheet	Development	This document contains data from the objective specification for product development.
Preliminary [short] data sheet	Qualification	This document contains data from the preliminary specification.
Product [short] data sheet	Production	This document contains the product specification.

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## 14. Contents

1. General description.....	1
2. Features and benefits .....	1
3. Applications .....	1
4. Quick reference data.....	1
5. Pinning information.....	2
6. Ordering information.....	2
7. Marking.....	2
8. Limiting values .....	3
9. Thermal characteristics .....	4
10. Characteristics.....	5
11. Switching Characteristics.....	6
12. Package outline .....	12
13. Legal information .....	13
14. Contents .....	15

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